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Ms. Becker:

Under this cover you will find a copy of my final report summarizing the results from the past four years of an EPSCoR State-DOE Laboratory Partnership Award *Studies of Correlated-Electron Systems in High Magnetic Fields and at High Pressures*. This is DOE Award Number DE-FG02-00ER45835 with a total award amount of $219,033 for the period 8/00-8/03 with a one year no cost extension). As this is the end of the award, I would like to thank DOE-BES and the EPSCoR program for the opportunity to perform the research outlined in this report. I feel overall that the project has been a great success and I look forward to continuing a working relationship with the Office of Basic Energy Sciences.

Sincerely,

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I. Studies of Correlated-Electron Systems in High Magnetic Fields and at High Pressures

The following summarizes the results from the past four years of an EPSCoR State-DOE Laboratory Partnership Award *Studies of Correlated-Electron Systems in High Magnetic Fields and at High Pressures* (DOE Award Number DE-FG02-00ER45835 with a total award amount of $219,033 for the period 8/00-8/03 with a one year no cost extension). Numerous publications and presentations came from the funding, and the PI received recognition in the form of an invited presentation at the 2003 DOE/EPSCoR conference *EPSCoR Powered: Pathways to Success* in Albuquerque, New Mexico.

A. Observation of Multiple Energy Scales in $YbAl_3$

$YbAl_3$ is an intermediate valent (IV) compound with a Kondo temperature T_K in excess of 500 K and a rather low conduction electron density of n_c~0.5/atom.[1] Recent theoretical studies[2-4] of the Kondo Lattice Model (KLM) and Anderson Lattice Model (ALM) suggest that the thermodynamic properties can differ in at least two ways from the predictions of the Anderson Impurity Model (AIM). First, a new low temperature scale T_{coh} for the onset of Fermi liquid coherence with $T_{coh} \ll T_K$. Second, as n_c decreases, the crossover from low temperature Fermi liquid behavior to high temperature local moment behavior becomes slower than predicted for the AIM. Though all of the theories predict $T_{coh} \propto T_K$, there is no universal relation between the two. We have experimentally observed both effects in $YbAl_3$.[1] First, the crossover from low temperature Fermi liquid behavior to high temperature local moment behavior is slower (i.e.,more gradual) than predicted for the AIM. Second, anomalies (relative to the AIM) in the magnetization, susceptibility specific heat, and magnetotransport occur below 30-40 K, which is the temperature scale T_{coh} for the onset of coherent Fermi liquid T^2 behavior in the resistivity. For $T \ll T_{coh}$ we indeed find that the magnetization "crosses" over from the zero field energy scale (T_{coh}) to the high temperature energy scale T_K at a magnetic field $B^* \approx 40$ T ($\approx k_B T_{coh}/\mu_B$) with little change in the shape of the Fermi surface (however the effective masses are all reduced by a factor of 2-3 relative to their low field values[5]). This is the first direct observation of the crossover between the T_{coh} and T_K energy scales in an IV compound.

In Kondo systems, the magnetic susceptibility $\chi(T)$ displays universal behavior as a function of T/T_K, and from the maximum in $\chi(T)$, one can obtain a value for T_K. In Fig. 1 results on $YbAl_3$ are shown. At 250 K ($T > T_{coh}$), linearity is observed up to the highest field of around 60 T. At 4 K ($T < T_{coh}$) there is deviation from linearity around $B^* \approx 40$ T as can be seen clearly in the difference plot shown in the inset to Fig. 1. The low field ($B = 0.1$ T) magnetic susceptibility measured in a SQUID magnetometer shows maxima at $T = 15$ K and 125 K that are related to T_{coh} and T_K respectively. From the slope of the M versus B curves at low fields, good agreement is seen with the SQUID data. Both of these data sets shows good agreement to an NCA calculation using $T_K = 565$ K for $T > 75$ K but deviate at lower temperatures. This is due to the new lower energy scale T_{coh} scale at low temperatures. For high fields, however, the slope of the M versus B for $B^* > 40$ T ($\approx k_B T_{coh}/\mu_B$) curves show good agreement to the calculations. This is clear evidence of a sudden change from the large energy scale to the small energy scale in high fields at low temperatures. These results show that magnetic susceptibility can be used to determine BOTH T_K and T_{coh}.

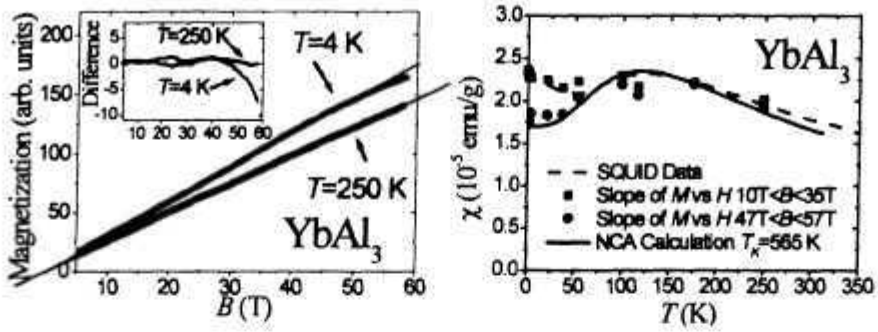

Figure 1: (left) The magnetization as a function of field for two different temperatures. The lines are linear fits to the data in the range (10 T< B < 35 T). The inset show the difference of the raw data and the linear fit. (right) Plots of the magnetic susceptibility $\chi(T)$ for very low fields (SQUID data), low fields (10 T< B < 35 T), high fields (10 T< B < 35 T) and the results of an NCA calculation with $T_K = 565$ K.

B. Magnetically Mediated Superconductivity in $CeRhIn_5$

One of the more extensively studied heavy fermion systems in the past few years is $CeRhIn_5$ and related compounds. $CeRhIn_5$ crystallizes in the quasi-two-dimensional (quasi-2D) tetragonal $HoCoGa_5$-type structure and displays antiferromagnetic (AF) ordering at $T_N \approx 3.8$ K. The electronic specific heat coefficient ($\gamma \geq 420$ mJ/mol K^2) determined for $T > T_N$ makes $CeRhIn_5$ a moderately heavy-fermion compound. The application of pressure induces a superconducting transition at $T_c = 2.1$ K.[6] The order of magnitude larger T_c compared to cubic $CeIn_3$ is attributed to the quasi-2D crystal structure. The PI has been submitted the second manuscript on $CeRhIn_5$,[7] and he has been actively studying it and related compounds as outlined below. The crystal structure of $CeRhIn_5$ can be viewed as $(CeIn_3)(RhIn_2)$ with alternating layers of cubic ($CeIn_3$) and tetragonal ($RhIn_2$) stacked along the c-axis. As theoretical models suggest that the SC state is enhanced for 2D magnetic correlations relative to 3D correlations,[8] the larger T_c in $CeRhIn_5$ relative to cubic $CeIn_3$ might be due to the difference in crystal structures. The magnetic and electronic properties of $CeRhIn_5$, as determined by heat capacity and de Haas-van Alphen measurements, can be well explained by postulating the formation of an anisotropic spin density wave (SDW) consistent with neutron measurements,[9] that opens a gap in the Fermi surface at low temperatures.[7] The anisotropy leads to the speculated quasi-2D nature of the magnetic interactions is a result of the tetragonal crystal structure of $CeRhIn_5$.

We have studied the elastic properties of Ce_nMIn_{2n+3} (M=Rh, Ir and Co) with $n = 1$ or 2 under hydrostatic and quasihydrostatic pressures up to 15 GPa using x-ray diffraction. The data collected on $CeRhIn_5$ is shown in Fig. 2. Since the maximum volume compression is only of the order of 10%, the $V(P)$ data has been fit using a least squares fitting procedure to the first order Murnaghan equation of state. For the room temperature ($T = 295$ K) data in Fig. 2, we find $B_0 = 78.4 \pm 2.0$ GPa and $B_0' = 5.6 \pm 0.6$. The addition of MIn_2 layers to the parent $CeIn_3$ compound is found to stiffen the lattice since $B_0 = 67$ GPa for $CeIn_3$.[10] The c/a data displays a double maxima as a function of pressure. An intriguing explanation for this result is that there are two superconducting states in $CeRhIn_5$: a higher temperature quasi-2D state at low

pressure and a lower temperature more 3D state at higher pressures. This scenario is supported by the experimental finding a two maxima in $T_c(P)$ in $CeRhIn_5$ and Ir substituted samples;[11,12] the maxima in $T_c(P)$ for $CeRhIn_5$ occur at nearly the same pressures as the maxima in c/a. As room temperature lattice properties are being correlated to superconductivity at low temperatures, it is important to make sure that the same lattice properties measured at room temperature hold at low temperature. A measurement at 10 K shown in Fig. 2 also displays the double maxima in c/a validating the use of room temperature values.

By plotting the maximum values of the superconducting transition temperature T_c versus c/a, we are able to expand upon the proposed linear relationship between the quantities by Pagliuso *et al.*[14] In Fig. 2, I plot normalized values of T_c versus $\Delta(c/a)$ in Fig. 2, where T_c is normalized by T^* and $\Delta(c/a)$ is found by subtracting a value $(c/a)^*$. T^* was chosen as 2 K for $CeMIn_5$ and Ce_2MIn_8 as it is approximately T_{sf} for $CeCoIn_5$,[15] and we don't expect much variation in T_K for these compounds. $T^* = 20$ K was used for $PuMGa_5$ as we expect an order of magnitude increase in T_K for Pu compounds relative to Ce compounds (the $PuMGa_5$ data is from Wastin *et al.*[16,17]). $(c/a)^*$ was chosen in such a way to shift the curves on top of each other. The universality is readily apparent. The ambient pressure "misplacement" of Ce_2RhIn_8 (AF order at ambient pressure) now can be explained by the pressure induced superconductivity and the universal line now goes through the high pressure Ce_2MIn_8 data. While Ce_2IrIn_8 does not display superconductivity, the value of c/a reaches a nearly constant value above 5 GPa and we have plotted a point assuming $T_c = 0$ at high pressure. This assumption gains validity as these results would predict that superconductivity will not be seen in Ce_2IrIn_8 under pressure as $\Delta(c/a)$ falls below the x-intercept of the T_c/T^* versus $\Delta(c/a)$ line. These results explain the lack of superconductivity in Ce_2IrIn_8 and predict that T_c should increase dramatically in Ce_2CoIn_8 at high pressure. Comparing the results to Pu-based superconductors shows a universal T_c versus c/a behavior when these quantities are normalized by appropriate quantities consistent with what is expected of magnetically mediated superconductivity.

The use of high pressure, high magnetic fields, and chemical substitution to alter the electron-electron (hybridization) interactions can suppress long range magnetic order that terminates at a quantum critical point (QCP). Near the QCP, a variety of exotic behavior can be observed including: short range magnetic order, non-Fermi liquid (NFL) behavior, heavy fermion behavior and superconductivity. We compare our heat capacity data using chemical substitution to both theoretical calculations of the anisotropic 2D Ising model and the high pressure data of Fischer *et al.* where superconductivity is observed.[13] To discuss the data in terms of short range magnetic interactions, we will look at the calculations for a 2D Ising model on a square lattice with two magnetic interaction energies E_{in} and E_{out} that correspond to the magnetic interaction energies along the two orthogonal directions.[18] To a first approximation, it seems reasonable to qualitatively describe our data using E_{in} as the interaction in the basal plane and E_{out} as the out of plane (interlayer) interaction. We fix $E_{in}/2 = T_N$ and vary E_{out} with the results shown in Fig. 2 where a dramatic effect on C_m/T is seen as T_N moves to lower temperatures and a Schottky-like maximum (or hump) becomes clearly visible. In the calculations, the heat capacity for the case $E_{in}/E_{out} = \infty$ shows no long range order and is identical to that of a two-state Schottky anomaly with an energy difference of E_{in} between the two levels. The evolution of the 2D Ising calculation is in excellent agreement with the data taken on $Ce_{1-x}La_xRhIn_5$ shown in Fig. 2. In this scenario, as La is doped for Ce, short range in plane magnetic correlations remain while those along the $c-$axis are weakened considerably by the disorder. The long range order is suppressed (disappears around $x = 0.40$) by

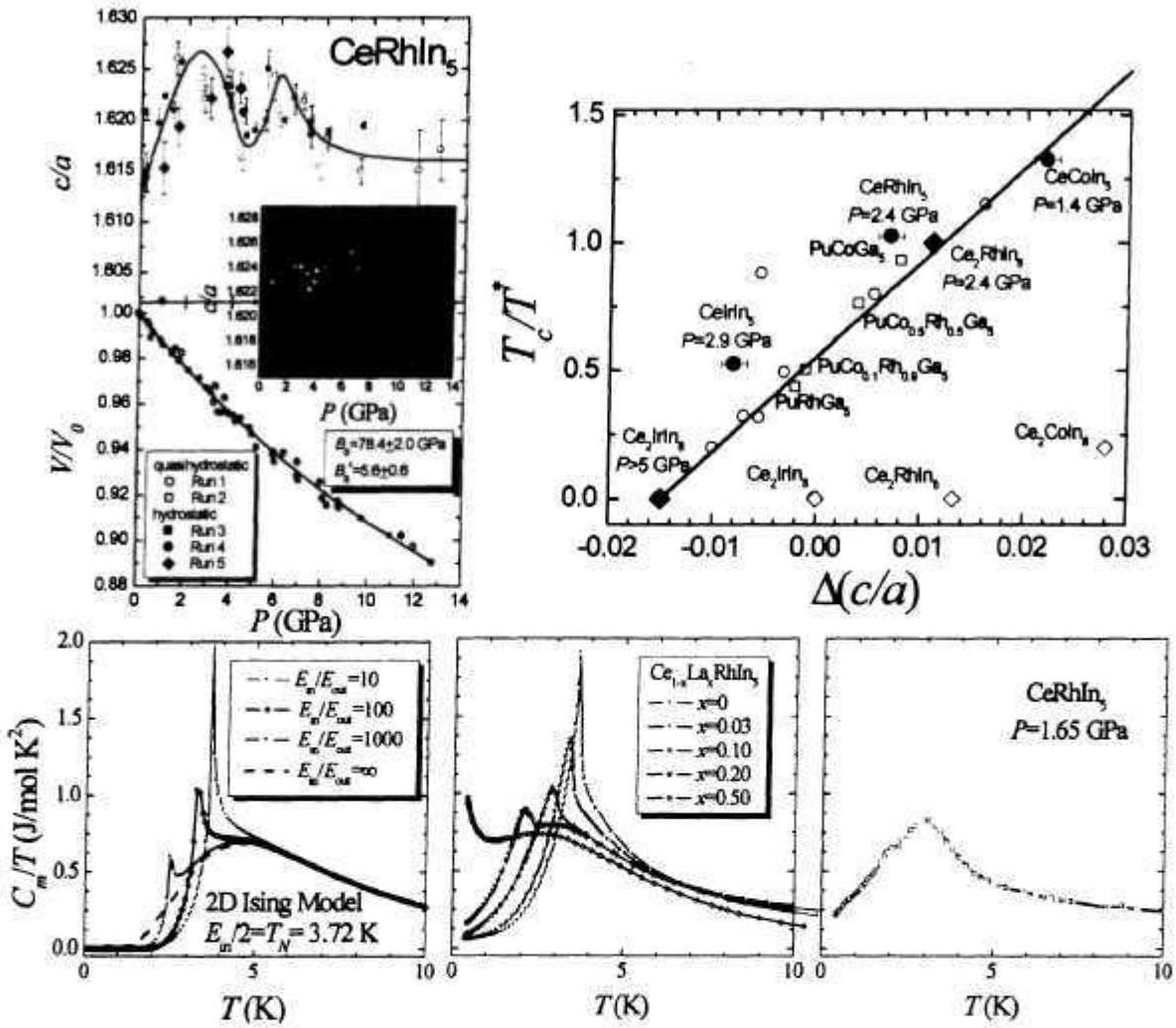

Figure 2: (Top Left) Normalized volume V/V_0 and ratio of tetragonal lattice constants c/a plotted versus pressure for $CeRhIn_5$ at room temperature. Data for both quasihydrostatic (open symbols) and hydrostatic (closed symbols) are displayed. The solid line through the volume data is a fit as described in the text. The inset shows the value of c/a versus P at 10 K. (Top Right) The ambient pressure values of T_c/T^* versus the room temperature value of $\Delta(c/a)$ (open symbols) for various Ho_nCoGa_{2n+3} based compounds; $CeMIn_5$ (circles), Ce_2MIn_8 (diamonds) and $PuMGa_5$ (squares) are all shown. Also shown (solid symbols) are the values of $\Delta(c/a)$ determined at room temperature at the pressure P_{max} where $T_c(P)$ displays a maximum. (Bottom Left) Magnetic heat capacity C_m divided by temperature T versus T as calculated for the 2D Ising model described in the text. $E_{in}/2$ has been fixed to the value of $T_N = 3.72$ K for $CeRhIn_5$ and E_{out} is varies. (Bottom Middle) C_m/T versus T measured on $Ce_{1-x}La_xRhIn_5$ in zero field. (Bottom Right) The high pressure heat capacity data of Fischer *et al.* at 1.65 GPa near the quantum critical point where a peak indicitive of short range order is seen near 3 K and small features due to long range order around 2.5 K and superconductivity near 1 K are also observed.[13]

alloying in a manner quite similar to the increasing anisotropy in the 2D Ising model shown to the left. The upturn in the $x = 0.50$ data is a logarithmic divergence typical of NFL behavior. The data at high pressure of Fischer *et al.*[13] is quite similar to the La doped sample near the QCP. Namely, the broad maximum at 3 K that can be attributed to SRO that is not shifted by magnetic field is seen in both cases. It is natural to conclude that the NFL (upturn at low temperature in the$x = 0.50$ sample) behavior in the La doped sample and the superconductivity observed under pressure in the undoped sample develop out of SRO. This behavior is consistent with an evolving picture of coexisting short and long range magnetic correlations in correlated-electron systems that holds promise for giving a universal description of these complicated materials.

C. Publications from DOE Support 2000-2004

- "Compressibility of CeMIn$_5$ and Ce$_2M$In$_8$ (M=Rh, Ir and Co) Compounds." Ravhi S. Kumar, A.L. Cornelius, and J.L. Sarrao, to appear in Phys. Rev. B (cond-mat/ 0405043)
- "X-Ray Absorption Studies of the Local Structure and f-Level Occupancy in CeIr$_{1-x}$Rh$_x$In$_5$." M. Daniel, S.-W. Han, C.H. Booth, A.L. Cornelius, P.G. Pagliuso, J.L. Sarrao, and J.D. Thompson, to appear in Phys. Rev. B
- "Compressibility of Nb$_2$AsC to 41GPa." Ravhi S. Kumar, Sandeep Rekhib, Andrew Cornelius and Michael W. Barsoum, submitted Appl. Phys. Lett..
- "Anisotropic Elastic Properties of CeRhIn$_5$." Ravhi S. Kumar, H. Kohlmann, B.E. Light, A.L. Cornelius, V. Raghavan, T.W. Darling, J.L. Sarrao, P.G. Pagliuso, N.O. Moreno, and J.D. Thompson, Phys. Rev. B **69**, 014515 (2004).
- "Heat Capacity Studies of Ce and Rh Site Substitution in the Heavy Fermion Antiferromagnet CeRhIn$_5$: Short-Range Magnetic Interactions and non-Fermi-Liquid Behavior." B.E. Light, A.L. Cornelius, P.G. Pagliuso and J.L. Sarrao, Phys. Rev. B **69**, 024419 (2004).
- "Uranium (and Cerium) Compounds At High Pressures and Magnetic Fields." A.L. Cornelius. MRS Proceedings Volume **802**, DD 7.7 (2004)
- "A New Energy Scale at Low Temperatures in YbAl$_3$." T. Ebihara, A.L. Cornelius, and J.M. Lawrence, Physica B **329**, 618 (2003).
- "Evolution of the Magnetic Ground State in the Electron-Doped Antiferromagnet CaMnO$_3$." A.L. Cornelius, B.E. Light and J.J. Neumeier, Phys. Rev. B. **68**, 014403 (2003).
- "Dependence of the Effective Masses in YbAl$_3$ on Magnetic Field and Disorder." T. Ebihara, E.D. Bauer, A.L. Cornelius, J.M. Lawrence, N. Harrison, J.D. Thompson, J.L. Sarrao, M.F. Hundley, and S. Uji, Phys. Rev. Lett. **90**, 166404 (2003).
- "Slow Crossover and Observation of a Second Energy Scale in YbAl$_3$ Above 40 T." A.L. Cornelius, T. Ebihara, and J.M. Lawrence, Acta Physica Pol. B **34**, 1299 (2003).

- "Ce-Site Dilution Studies in the Antiferromagnetic Heavy Fermions $Ce_mRh_nIn_{3m+2n}$ $(m = 1, 2; n = 0, 1)$." P. G. Pagliuso, N. O. Moreno, N. J. Curro, J. D. Thompson, M. F. Hundley, J. L. Sarrao, Z. Fisk, A. D. Christianson, A. H. Lacerda, B. E. Light, and A. L. Cornelius, Phys. Rev. B **66**, 054433 (2002).

- "Observation of a Second Energy Scale in $YbAl_3$ Above 40 T." A.L. Cornelius, T. Ebihara, J.M. Lawrence, P.S. Riseborough, and J.D. Thompson, in Physical Phenomena in High Magnetic Fields IV, G. Boebinger, Z. Fisk, L. Gor'kov A. Lacerda and J.R. Schrieffer, eds., (World Scientific, 2002) 82.

- "Observation of a Second Energy Scale in $YbAl_3$ Above 40 T." A.L. Cornelius, T. Ebihara, J.M. Lawrence, P.S. Riseborough, and J.D. Thompson, Int. J. Mod. Phys. B **16**, 2992 (2002).

- "Two Energy Scales and Slow Crossover in $YbAl_3$." A.L. Cornelius, J.M. Lawrence, T. Ebihara, P.S. Riseborough, C.H. Booth, M.F. Hundley, P.G. Pagliuso, J.L. Sarrao, J.D. Thompson, M.H. Jung, A.H. Lacerda, and G.H. Kwei, Phys. Rev. Lett. **88**, 117201 (2002).

- "Thermodynamic Investigation of the Magnetic Phase Transitions of $CaMnO_3$ And $SrRuO_3$." J.J. Neumeier, A.L. Cornelius, and K. Andres, Phys. Rev. B **64**, 172406 (2001).

- "Field-induced Magnetic Transitions in the Quasi-Two-Dimensional Heavy Fermion Antiferromagnets Ce_nRhIn_{3n+2}." A.L. Cornelius, P.G. Pagliuso, M.F. Hundley, and J.L. Sarrao Phys. Rev. B **64**, 144411 (2001).

- "Local and Average Crystal Structure and Displacements of $La^{11}B_6$ and EuB_6 as a Function of Temperature." C.H. Booth, J.L. Sarrao, M.F. Hundley, A.L.Cornelius, G.H. Kwei, A. Bianchi, Z. Fisk, and J.M. Lawrence." Phys. Rev. B **63**, 224302 (2001).

- "Anisotropic Electronic and Magnetic Properties of the Quasi-Two-Dimensional Heavy-Fermion Antiferromagnet $CeRhIn_5$." A.L. Cornelius, A.J. Arko, J.L. Sarrao, M.F. Hundley, and Z. Fisk, Phys. Rev. B **62**, 14181 (2000).

D. Invited Presentations

- "Correlated-Electron Systems at High Pressures". A.L. Cornelius. Invited talk at the Gordon Conference Research at High Pressure, Boston, MA. 30 minutes. June 30, 2004

- "Uranium (and Cerium) Compounds At High Pressures and Magnetic Fields." A.L. Cornelius. Invited talk at the Fall Meeting of the Materials Research Society, Boston, MA. 30 minutes. December 3, 2003.

- "Studies of Correlated-Electron Systems in High Magnetic Fields and at High Pressures." A.L. Cornelius. Invited talk at the DOE EPSCoR Conference 2003, Albuquerque, New Mexico. 20 minutes. June 4, 2003.

- "Magnetic Measurements on $YbAl_3$ in Pulsed Magnetic Fields to 60 T: The Observation of Two Energy Scales and Slow Crossover." A.L. Cornelius. Invited talk at the National High Magnetic Field Laboratory, Los Alamos, New Mexico. 60 minutes. August 23, 2002.
- "Slow crossover and observation of a second energy scale in $YbAl_3$." A.L. Cornelius. Invited talk at the Strongly Correlated Electron Systems Conference (SCES 2002), Krakow, Poland. 20 minutes. July 10, 2002.
- "Observation of a Second Energy Scale in $YbAl_3$ Above 40 T." Invited Talk at PPHMF-IV in Santa Fe, NM. October 21, 2001. A.L. Cornelius, T. Ebihara, J.M. Lawrence, P.S. Riseborough, and J.D. Thompson
- "Magnetic Measurements on Correlated-Electron Systems in Pulsed Magnetic Fields to 60 T." A.L. Cornelius. Condensed Matter Seminar at University of California, Santa Cruz. 60 minutes. February 22, 2002.
- "Suppression of Long Range Magnetic Order." Washington University, St. Louis, April 9, 2001.
- "Studies of Magnetism and Superconductivity in Heavy Fermion Systems." NATO Workshop Frontiers Of High Pressure Research II: Application Of High Pressure To Low-Dimensional Novel Electronic Materials, June 2001.

E. Contributed Presentations

- "Heat Capacity Studies of Ce and Rh Site Substitution in the Heavy Fermion Antiferromagnet $CeRhIn_5$: Short-Range Magnetic Interactions and non-Fermi-Liquid Behavior." B.E. Light, A.L. Cornelius, P.G. Pagliuso and J.L. Sarrao, Contributed Talk at March Meeting of the American Physical Society, Montreal, QUE, 15 minutes, March 22, 2004.
- "X-Ray Absorption Studies of the Local Structure and Electronic Configuration in $CeIr_{1-x}Rh_xIn_5$." M. Daniel, C.H. Booth, A.L. Cornelius, S.-W. Han, and J.L. Sarrao, Contributed Talk at March Meeting of the American Physical Society, Montreal, QUE, 15 minutes, March 22, 2004.
- "Spin Relaxation Processes in the Frustrated Ising System $Ho_2Ru_2O_7$." A.L. Cornelius and J.S. Gardner, Contributed Talk at March Meeting of the American Physical Society, Montreal, QUE, 15 minutes, March 22, 2004.
- "Structural Studies of $La_{2-2x}Sr_{1+2x}Mn_2O_7$ Bilayer Manganites." Ravhi Kumar, YongRong Shen, Andrew. Cornelius, Prabhakaran Dharmalingam, and Andrew Boothroyd, Contributed Talk at March Meeting of the American Physical Society, Montreal, QUE, 15 minutes, March 23, 2004.
- "Pressure induced amorphization of $Tb_2Ti_2O_7$ pyrochlore." Ravhi Kumar, YongRong Shen, Andrew. Cornelius, and Jason Gardner, Contributed Talk at March Meeting of the American Physical Society, Montreal, QUE, 15 minutes, March 23, 2004.

- "Low Temperature, High Pressure Physics." A.L. Cornelius. Contributed presentation at UNLV-DOE Nevada Stockpile Stewardship Review. 30 minutes. December 5, 2003.

- "A New Intermediate Amorphous Phase Pathway in B1■B2 Transition." Ravhi S. Kumar, Yongrong Shen, Eunja Kim, Andrew Cornelius, Changfeng Chen, Malcolm F Nicol, and S. Yoneda. Contributed poster. Gordon Conference Research at High Pressure, Boston, MA. 30 minutes. June 28, 2004.

- "Anisotropic Elastic Properties of $CeRhIn_5$." Ravhi S. Kumar, H. Kohlmann, B.E. Light, A.L. Cornelius, V. Raghavan, T.W. Darling, J.L. Sarrao, P.G. Pagliuso, N.O. Moreno, and J.D. Thompson, Contributed Talk at March Meeting of the American Physical Society, Austin, TX, 15 minutes, March 6, 2003.

- "Evolution of the Magnetic Ground State in the Electron-Doped Antiferromagnet $CaMnO_3$." B.E. Light, A.L. Cornelius, and J.J. Neumeier, Contributed Talk at March Meeting of the American Physical Society, Austin, TX, 15 minutes, March 5 2003.

- "Field Dependent Effective Masses in $YbAl_3$." T. Ebihara, A.L. Cornelius, J.M. Lawrence, S. Uji, and N. Harrison, Contributed Talk at March Meeting of the American Physical Society, Austin, TX, 15 minutes, March 4, 2003.

- "Observation of Multiple Spin Relaxation Processes in Dysprosium Titanate." A.L. Cornelius, B. Yulga, B. Light, and J. Gardner, Contributed Talk at March Meeting of the American Physical Society, Austin, TX, 15 minutes, March 4, 2003.

- "Studies of Magnetism in Correlated-Electron Systems." A.L. Cornelius. Contributed presentation at UNLV-DOE Nevada Stockpile Stewardship Review. 30 minutes. November 2, 2002.

- "A new energy scale at low temperature in $YbAl_3$." T. Ebihara, A.L. Cornelius, and J.M. Lawrence. Contributed talk. 23rd Int. Conf. on Low Temperature Physics, Hiroshima, Japan, August 23, 2002.

- "Studies of Correlated-Electron Systems in High Magnetic Fields and at High Pressures." A.L. Cornelius. Contributed presentation DOE/EPSCoR Site Visit for the University/National Laboratory Collaboration Program. 15 minutes. February 26, 2002.

- "Anisotropic Elastic Properties of $CeRhIn_5$ and Related Compounds." Ravhi S. Kumar, H. Kohlmann, B.E. Light, A.L. Cornelius, V. Raghavan, T.W. Darling, J.L. Sarrao, P.G. Pagliuso, N.O. Moreno, and J.D. Thompson. Poster presented at the Gordon Conference entitled Research at High Pressure. June 25, 2002.

- "Studies of Magnetism in Correlated-Electron Systems." A.L. Cornelius. Contributed presentation at the Annual Review of the DOE Nevada Stockpile Stewardship Program. 15 minutes. September 23, 2001.

- "de Haas-van Alphen effect, magnetic transitions and specific heat in the heavy fermion antiferromagnet $CeRhIn_5$." A.L. Cornelius, A.J. Arko, J.L. Sarrao, M.F. Hundley, J.D. Thompson, and N. Harrison, Contributed Talk at March Meeting of the American Physical Society, Minneapolis, MN, 15 minutes, March 23, 2001.

II. Research Bibliography

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